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Household Surface Lead Dust: Its Accumulation in Vacant Homes

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House dust has been suspected as a source of lead in the exposure of children, particularly those whose blood lead levels are in the moderately elevated range. The means by which household surface lead accumulates is at present not clear. By towel wipe sampling, 24 vacant houses in urban Rochester and Buffalo, New York, were examined for lead content on windowsills, floors, and other surfaces. High yields of lead were obtained from windowsills and floor areas adjacent windows. When washed and resampled, these areas yielded greatly reduced lead values. It is suggested that surface lead may represent a deposit phenomenon. The entry of exterior airborne particulate lead around the loose-fitting windows of older homes appears possible.

The widespread phenomenon of low level lead exposure in children has presented many perplexing problems. It now seems possible that there may be a number of sources of significant lead exposure in addition to the ingestion of paint chips. The possibility that lead in dust may be in part responsible for this exposure has received attention in recent years (*1–8*). The study of Baker et al. (*4*), backed up by subsequent reports (*5–7*) suggests that lead dust brought into homes on the clothing of lead smelter workers is deposited on interior household surfaces to which children then have access. Studies in Rochester, New York (*1*), where there is no indication of such industrial exposure, have suggested that surface dust lead may nonetheless be a widespread and potent lead source. In these studies significantly increased amounts of lead were found on the hands of exposed children. The hypothesis was made that normal hand-to-mouth activity in the child could be a mechanism of access in child exposure.

As yet it has not been determined whether this lead found on household interior surfaces represents (a) a chalking or wearing of the paint covering, that is, a breakdown in the integrity of the paint itself, (b) lead tracked in under foot or introduced by other means by occupants, or (c) atmospheric fall-out lead which gains entry from the outside.

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Materials and Methods

We examined 24 vacant houses; 19 in Rochester, New York, and 5 in Buffalo, New York. These houses were at the time owned by the U. S. Department of Housing and Urban Development (HUD), having been taken over by that agency because of default of taxes or mortgage payments, or abandonment. None had been known to present a lead exposure hazard. The age of these houses was between 52 and 107 years (Rochester) and 55 to 77 years (Buffalo). The Rochester homes were located in two general areas: one on the west side (Rochester West) of town, the other on the east (Rochester East). The Buffalo homes were close to the center of the city. All three areas were urban residential. All homes were located on short, little-travelled streets. The Rochester West homes were clustered within an area less than 0.3 square miles in size; the Rochester East homes within an area less than 0.4 square miles. The Buffalo homes were closer, being on two streets only, located only three blocks distant from one another. In no direction from any of the homes was there an arterial highway carrying over 20,000 average daily transit (ADT) less than one half a mile distant. ADT's identified for more travelled streets in these areas ranged from 1,400 to 16,500. There are no identified lead particle emitting stacks in any of the areas. The period of known vacancy prior to our study ranged from two to 60 months. This vacancy period, we were informed, could have been several months longer than the times given us since the only dates available to HUD were those of transactions with banks and other agencies. All houses had been totally emptied of furniture, containing only bathroom and kitchen fixtures. Three of the houses had wall-to-wall carpeting in some of the downstairs rooms. These houses were kept locked at all times; most with boards on the outside of the downstairs windows. Although the possibility of periodic entry by vandals cannot be denied, there was little evidence of property destruction visible. With the consent of HUD we carried out interior surface sampling by a method of paper towel wipes (*1*, *9*) used in previous studies. Our sampling procedure is to rub briskly the floor, wall, or counter surface area of 0.09 m^2 (1 ft^2) with the towel. In sampling a windowsill we rub the full length of the flat sill interior to the window. Care is taken to sample sills and floor areas which do not have cracks or chips in the paint. The surface area of windowsills was not measured in the sampling. Separate measurements of sill areas suggest this area ranges from 0.05 to 0.08 m^2 (or 60–90% of the floor area). No correction for this variable was made in reporting windowsill surface lead levels. All sampling was done between August 9 and October 13, 1977. Analysis of the towels for lead content was done by atomic absorption spectrophotometry, measuring the amount eluted in 0.1*N* HCl overnight. The method determines total lead content per towel. Percentage yield in this technique has been reported (*9*). For the sake of comparison with studies by others, several collections of dust were made by scraping surfaces lightly with the edge of a piece of paper.

Towel wipe samples were taken from windowsills, floors, walls, and the Formica tops of kitchen cabinets. Floor wipe samples were taken adjacent to the windowsill sampled and at measured distances inward from the window. Following initial sampling of a number of these areas the tested surface was cleansed with water and a scrub brush and dried with a paper towel. A second towel wipe sample was then taken from the area cleaned.

Results

Table 1 gives the results of towel rub studies of the windowsills and floors of three separate community areas studied. There was a considerable range of towel lead values obtained which are grouped into four categories: 0–99, 100–499, 500–999, and over 1000 μg per towel. The median values of these results varied from 192 to 651 μg per towel in the listed localities. Our previous studies of windowsill and floor samples yielded a median level of 100 μg per towel with two values over 500 in the lead-exposed inner city group (*1*). The suburban control group had a median towel level of 28 μg with two values over 100 (*1*).

Walls sampled in the Rochester homes were low in lead values. Of 39 samples from 15 homes the group mean was 26.2 μg per towel with a range of 3 to 88 μg per towel. Levels on the hands of the investigator taken during these studies ranged from 8 to 24 μg/towel.

Table 2 shows towel lead values from 10 separate areas where the surface was sampled before and after a scrub with water and a brush. All but one of the afterwash specimens yielded negligible values (about the same as we commonly find on the hands of the examiner).

In the study enumerated in Table 3 a series of specimens were taken proximate to windows: from the sill, the floor immediately beneath that sill, the floor 2 m and 3 m interior to that window. The floor adjacent the window yielded values comparable to the windowsill; the floor more remote from the window tended to be lower.

Table 4 lists the means of specimens from windowsills and floors of each house grouped by the year of construction of these 24 houses. No clear relationship to the age of the dwelling is apparent.

The relationship of windowsill lead levels to the time of vacancy of houses was examined using the time as the independent variable. The correlation coefficients were: Rochester houses, $r = -0.01$; Buffalo houses, $r = -0.05$; combined, all houses, $r = -0.04$.

Table 1. Interior household surface lead by location and sample sites.

Location	No. homes tested	No. of specimens	Towel lead, μg/towel: Median	Range	Clustered results of towel values: 0–99 μg	100–499 μg	500–999 μg	>1000 μg
Sills								
Rochester West	11	37	539	45–8160	2	15	8	12
Buffalo Center	5	13	376	152–806	—	7	6	—
Rochester East	8	26	404	10–5168	1	15	8	2
Floors								
Rochester West	7	27	384	37–968	2	19	6	—
Buffalo Center	5	9	192	43–368	4	5	—	—
Rochester East	4	4	651	208–1024	—	2	—	2

Table 2. Effect of washing on surface lead levels.

Surface	Lead level, μg/towel[a] Before washing	After washing
Sill	365	ND
Sill	125	8
Sill	232	8
Sill	640	11
Sill	1184	176
Sill	541	8
Sill	336	8
Floor	232	6
Floor	192	38
Formica counter	200	5
Formica counter	294	8

[a] ND = none detected.

Table 3. Towel lead by distance from window.

Location	Lead level, μg/towel Windowsill	Floor adjacent to window	2 m into room	3 m into room
1	301	384	125	106
2	792	880	37	72
3	933	968	406	347
4	2640	3819	418	354
5	933	669	171	171
6	1267	413	130	200
Median	933	774	150	185
Mean	1144	1189	214	208

Table 4. Sills and floors grouped by age of dwelling.[a]

Year of construction	Sill n	Sill Mean lead, μg/towel	Floor n	Floor Mean lead μg/towel
Before 1890	4	542	1	1024
	3	1763	1	493
	2	1259	1	123
1890–1910	5	381	1	202
	6	162	2	64
	4	446	1	192
	3	374	1	232
	3	507	0	—
	2	207	1	208
	4	465	7	353
	4	400	1	206
	4	3208	8	848
	3	438	1	1664
	5	1989	0	—
	3	228	1	560
	2	994	1	357
	3	1428	0	—
	2	248	3	289
1911–1925	8	591	8	292
	4	485	1	278
	2	223	0	—
	3	921	1	1866
	4	954	1	1232
	2	465	2	48

[a] n = number of specimens taken at that dwelling; mean = arithmetic mean of lead level of specimens.

From four areas we collected enough dust to measure quantitative dust lead. Two samples from sills yielded 7300 and 6268 μg/g; a floor sample, 593 μg/g; dust deposited in a bathtub immediately beneath a window yielded 7550 μg/g.

Discussion

Since these studies have been done on older houses and are restricted to two geographic areas, the results cannot necessarily be more widely applied without documentation. All the houses were unoccupied at the time of study. It should not be inferred that these findings prevail when such houses are occupied. The value of this study of empty houses lies in the opportunity to look at the results of a sustained and undisturbed exposure. The setting of this study afforded us the liberty of taking specimens at designated locations and to observe the effects of cleaning with scrub brush and pail.

The amount of lead accumulated is surprisingly high when compared with our previous studies. Twelve floor values and 34 sill values exceeded the highest values seen in our previous study.

The surface lead samplings were greatly reduced following washing of sills, floors, and Formica-surfaced cabinets. This observation lends a strong argument to the idea that a deposit phenomenon occurs on the surfaces of such houses. Many of the sills with high levels of lead were, in fact, covered with varnish, not paint. The gradient of surface sample levels from sill toward the interior of the rooms would appear in agreement with the possibility that an entry of dust takes place at the window: around, under, or between the frames. A sooty deposit was commonly noted on the windowsills and the floor beneath. Accumulations were also evident in several bathtubs when adjacent to windows.

In these older houses we commonly noted that windows fitted poorly in their frames. In only five locations did we find storm windows of any sort on the outside of the windows. Towel samples from such windowsills yielded somewhat lower values, but the number was small.

From this study no statement can be made as to the ultimate source of the lead. As yet we have made no analysis of the dust obtained that would allow us to say whether it comes from paint, automotive emissions, or perhaps a combination of both.

The observation that older unoccupied urban homes have a potential to accumulate surface dust lead which appears in larger amounts at or near windows suggests that an active dynamic process may go on in the absence of occupants. We suspect that loosely fitting older style windows plays a role in allowing entry of dust from the outside. It seems possible that such a process may at least in part be related to atmospheric air levels of lead. A further study of the effect of more tight-fitting windows is currently being carried out.

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